

# Space Batteries

*INL will deliver  
the Power to  
Explore Pluto*

RTGs and RHUs generate electricity and heat to power satellites and probes to the deep recesses of space.

*Reliable Energy for  
Space Exploration*

## RTG

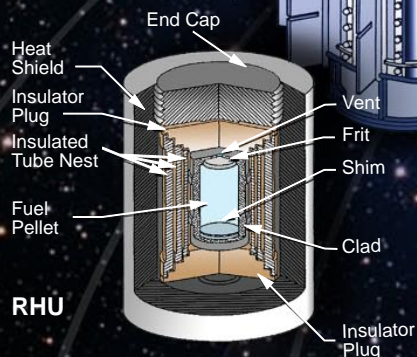
Cooling Tubes

Cooling Fins

Thermocouples

General Purpose  
Heat Source  
(GP-7)

Height: 44 inches  
Diameter: 16.8 inches  
Weight: 124.5 pounds  
Power: 240-300 watts



## RHU

The INL is one of the U.S. Department of Energy's multiprogram national Laboratories, and is managed by Battelle Energy Alliance, LLC.



**INL**  
Idaho National Laboratory



## Idaho's National Laboratory

Idaho National Laboratory has been identified as the preferred site where the United States Department of Energy is proposing to consolidate nuclear operations associated with the production of radioisotope power systems for NASA and other customers. Already, final assembly and testing of these so-called "space batteries" is under way in Idaho.

The first NASA mission Idaho scientists and engineers will support is the fueling and testing of a

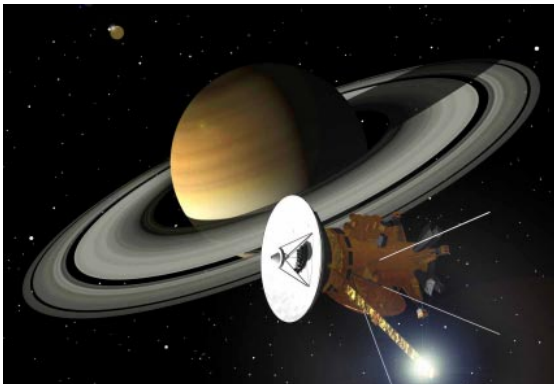


radioisotope power system for the New Horizons mission to Pluto. New Horizons is scheduled to launch in January 2006, cross the outer

solar system in record time and conduct flyby studies of Pluto and its moon, Charon in 2015. Its assignment is to probe the "third zone" of the solar system known as the Kuiper Belt, populated by smaller, icy objects different from the rocky inner planets or the outer gas giants.

## Why power systems in space?

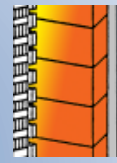
Radioisotope Thermoelectric Generators or RTGs are electrical power systems used in space exploration because they can safely and reliably produce electricity 24 hours a day, seven days a week for several decades. RTGs have two key components: a heat source and an energy conversion system. RTGs work by converting heat to electricity using a



device called a thermocouple. A thermocouple generates an electric current when one side of it is heated and the other cooled. The largest RTGs, which are those on the Cassini spacecraft, produce about 285 watts of electricity each.

The properties of a thermocouple have been known and used in a variety of applications for more than 150 years. The material used as a heat source has been used in a variety of space missions for the past 40 years.

## What is a General Purpose Heat Source?



The General Purpose Heat Source (GP-He) is the building block for the RTG. These heat sources contain quadruple-encapsulated Plutonium-238 (Pu-238) used to produce heat, which is subsequently converted into electricity.

## Why not other energy sources?

In space, power is a precious commodity. In Earth's orbit, a five-foot-square solar panel will produce about 300 watts of electricity which is about as much as an RTG. To produce the same power at Saturn, where the Sun's intensity is only 1 percent of what it is on Earth, would require a 6,430 square foot solar array - about the size of a football field. A launch of a spacecraft with such a solar array would not be possible. Without systems like these that enable spacecraft to operate reliably and predictably for many years in harsh environments, exploration into the far reaches of the solar system would not be possible.



## Why is plutonium fuel used?

Many people do not realize that not all plutonium is the same. Pu-238 is very different from its much longer-lasting cousin, plutonium-239 that has both peaceful and military applications. Pu-238 is an isotope that is used in space, and in the past, was even used in medical applications such as cardiac pacemakers.

While looking for elements that would work the best under the harsh conditions of space, scientists

tried many options and found that Pu-238 provided just the right amount of heat and power to spacecraft for just the right amount of time.

## What are Radioisotope Heater Units?

Many spacecraft use solar energy to provide heat to keep their structure, systems and instruments warm enough to operate. However, in deep space or on the dark side of planets, other technologies must be used to heat and provide electricity to the spacecraft.

Radioisotope Heater Units or RHUs are compact cylinders - the size of a spool of thread - and generate heat from the decay of a small pellet of Pu-238. The fuel pellet is about the size and shape of a pencil eraser and is surrounded by multiple layers of high-strength materials that are resistant to heat.

NASA scientists use these RHUs for heat in certain applications because they are reliable, have no moving parts and the heat produced is independent of the distance from the sun. They can protect the craft's sensitive instruments from damage in the cold vacuum of outer space which can reach -400 degrees Fahrenheit. The Mars landers Spirit and Opportunity are each using eight of these space heater units to keep their electronics warm on the cold Martian nights. Each RHU produces about 1 watt of heat.

## Atoms for Peace

Today, we recognize the vision of President Dwight Eisenhower, who over 50 years ago delivered his historic Atoms for Peace speech before the United Nations. President Eisenhower called for the peaceful uses of nuclear energy and today, as part of the legacy of his vision, systems like these will continue to enable us to better understand the Universe.

